Foreword

This issue of the *ICF Quarterly* is dedicated to the ICF Program's calculational capabilities and accomplishments. Computer codes are an integral part of the collection of research tools and activities that are used to investigate target physics and laser science and technology. With the advent of the Accelerated Strategic Computing Initiative (ASCI), a new emphasis has been placed upon computing as a core Laboratory competency. The ICF Program has long depended upon sophisticated computer codes to model in detail physical processes important in hardware and experiments. Currently, the emphasis is on extending simulations to three dimensions and on the use of high-performance computing platforms. Most of the codes in this issue exploit some form of parallel processing.

Two articles discuss codes used to simulate plasma behavior. The first is "WARP3D, a Three-Dimensional PIC Code for High-Current Ion Beam Propagation Developed for Heavy-Ion Fusion." WARP3D combines the particle-in-cell technique used for plasma modeling with a description of a "lattice" of accelerator components. It can simulate space-charge-dominated beams in realistic accelerator geometries. A detailed understanding of beam behavior as it propagates through the accelerator is necessary to maintain the low temperatures required to achieve a small focal spot size. In the second article, "Three-Dimensional Nonlinear Hydrodynamics Code to Study Laser–Plasma Interactions," direct numerical simulations examine ponderomotive filamentation produced by intense laser beams. Ponderomotive self-focusing and filamentation are important because they can prevent laser energy from being deposited at the desired location or with the required uniformity. The code solves the two-temperature fluid equations, coupled to the paraxial equation for light-wave propagation.

Radiation hydrodynamics codes are used to design ICF experiments and to analyze target evolution. The two-dimensional (2-D) axisymmetric code LASNEX has helped to improve our understanding of ICF targets for 25 years. The article "LASNEX—a 2-D Physics Code for Modeling ICF" describes the broad variety of physics packages and capabilities that have been incorporated into the code. Specific examples illustrate the code's success in simulating hydrodynamic instability evolution of 2-D perturbations as well as spectroscopic emission in Nova targets. Experiments and numerical simulations have shown that three-dimensional (3-D) surface perturbations saturate at larger amplitudes than axisymmetric or 2-D structures. Two radiation hydrodynamics codes are being developed in the ICF Program to examine 3-D effects. HYDRA, which is based upon a block structured mesh, can perform direct 3-D numerical simulations of portions of ICF capsules, carrying the evolution of multimode perturbations through ignition and burn. The article "Three-Dimensional Simulations of National Ignition Facility Capsule Implosions with HYDRA" describes early results from the first 3-D simulations of the NIF baseline capsule design. "The ICF3D Code" outlines the development of the 3-D hydro code based upon an unstructured grid that uses discontinuous finite-element hydrodynamics. ICF3D is written using object-oriented programming and can presently run on massively parallel computers. Results from several test problems are also presented.

Computer codes have been used to design high-power lasers both previously in the ICF Program and for the National Ignition Facility (NIF). Four articles describe a suite of codes used to optimize the NIF laser design. In the article "The PROP92 Fourier Beam Propagation Code," the author describes the code used to model the propagation of the laser beam through a comprehensive set of optical elements. Algorithms assess the risk of damage to optical elements from high beam fluence or filamentation. The detailed fields calculated with PROP92 are input into the code, which models the process of nonlinear frequency conversion, as described in the article "Frequency-Conversion Modeling." The article "Laser Optimization Techniques" describes a set of codes that employ various quadratic methods for locating the constrained nonlinear optimum of a multivariate system. To perform an iteration, the optimization code runs both the PROP92 and frequency conversion codes in parallel on a cluster of workstations. The article "NIF Design Optimization" outlines the modeling procedures used in the aforementioned laser design codes. It also presents results from the optimization that resulted in the current NIF design.

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